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Chapter 6. System Reoperation

System reoperation in the context of water resources means changing existing operation and management procedures for a water resources system consisting of supply and conveyance facilities and end user demands with the goal of increasing desired benefits from the system. System reoperation may seek to improve existing water facilities to more efficiently and reliably meet existing system needs or it may seek to prioritize one system need over another. Although reoperation of existing facilities is generally regarded as the preferred alternative to construction of major new facilities, minor physical modifications to existing facilities may be necessary to reduce bottlenecks and to meet operational goals. Changes to the water rights or regulatory framework for allocating water may also be required, for example, modifying existing water rights or creating new supply exchange agreements.

Some systems may be very simple and include only a single surface water reservoir or groundwater basin. Other water systems may be much more complex, consisting of many facilities that form a combination of local, interregional, and interstate water sources and destinations. The concept of "system reoperation" applies to whatever the system may be. Reoperation can be implemented at different scales within a system ranging from individual facilities to several integrated components.

Reoperation of existing facilities usually serves three basic purposes: (1) to address a specific problem, (2) to improve efficiencies or (3) to adapt to anticipated future changes. Good examples of factors driving reoperation are changes in water demands, changes in legal and regulatory constraints or changes in key physical variables such as climate.

System Reoperation in California

Reoperation is not a new tool for California water supply managers. The State Water Project (SWP) and Central Valley Project (CVP) have been coordinating their water supply operations since the 1970s through annual agreements. These annual agreements were eventually finalized in 1986 with the signing of a long-term Coordinated Operating Agreement (COA). COA has led to significant improvement in how the two projects work together to meet both water supply delivery needs and Delta ecosystem requirements. Although numerous reoperation studies and some actual reoperation changes have been implemented to date in California, most have applied to only a portion of the SWP-CVP system, such as a single reservoir or other facility, and have not fully integrated the entire SWP-CVP system.

Reoperation to Address a Specific Problem

To date, most assessments and actual reoperations in California have addressed only a specific problem or need at a specific facility, not multiple needs at multiple facilities throughout a larger system. Reoperation is often considered as one strategy in an integrated water management plan or one alternative among a set of alternatives in a feasibility study. Examples of reoperation in California to address a specific need or applied to a single project or facility include the following:

- Shasta Temperature Control Device. The original Shasta design did not allow temperature controlled water releases for ecosystem purposes through the powerhouse and therefore reduced hydropower generation capabilities. A temperature control device was added which allows for cold water releases through the powerhouse and restored hydropower generation. Water is drawn from different lake levels at different times of the year to meet the downstream requirements and to manage the cold water reserves behind the dam.
- The Environmental Water Account (EWA). EWA was an element of the CALFED Bay-Delta Program's overall management strategy for the Bay-Delta ecosystem. EWA's purpose was to provide greater protection to Bay-Delta Estuary fish by implementing environmentally beneficial changes in CVP and SWP operations without impacting water supply to the projects' users.
- San Joaquin River Restoration Program. Restoring salmon to the San Joaquin River between Friant Dam and the Merced River will require changes in Friant Dam operations to meet both existing agricultural water supply needs and new required restoration flow releases. Planned facilities and operational changes included options to recapture, reuse and replace a portion of the ecosystem flows to help meet existing agricultural water supply needs.

Reoperation to Improve Efficiencies

Reoperations to improve existing operational efficiencies generally involve consideration of the whole system and the implementation of new technologies to existing operations. Some examples of completed or on-going system reoperation efforts to improve existing operational efficiencies are as follows:

- Risk-Based Water Deliveries. A 1976-1977 drought in California prompted many water agencies to move away from operating water projects based upon the firm-yield approach to a risk-based approach when making system delivery decisions. The firm-yield approach seeks to deliver the same amount every year regardless of water supply conditions while the risk-based approach balances increasing deliveries in a given year with the risk of not meeting full deliveries in a subsequent dry year. The CVP and SWP both operate using a risk-based approach to make deliveries.
- Forecast-Coordinated Operations (F-CO). The primary F-CO program goal is to improve downstream flood protection without impacting water supply through better hydrologic forecasting and coordinated reservoir operations. The F-CO program aims to improve reservoir inflow forecasting, develop new reservoir release decision tools and enhance interagency communications and coordinated operations of multiple reservoirs. All of these program components work together to: allow operators to draw down reservoirs earlier; create storage space in anticipation of major flood events; avoid downstream channel flooding due to major reservoir releases and increase warning times to downstream communities. The F-CO program is currently being implemented on the Yuba-Feather river system with plans to develop and implement the program for other major reservoirs in the Central Valley.
- Forecast-Based Operations (F-BO). F-BO is a concept used to operate a multi-purpose reservoir. F-BO utilizes advanced reservoir inflow forecasts to reduce uncertainty and improve risk management in reservoir system operations. One example of F-BO based reoperation is currently being developed at Folsom Dam and Reservoir where F-BO reoperation allows the flood storage rule curves to be modified based on forecasted inflows thus improving flood protection while also maintaining or increasing water supply potential.

Reoperation in Anticipation of Future Changes

Large-scale system reoperation provides an important way to not only improve existing operations but more importantly to adapt multiple existing water systems to future changes such as increased demands due to population growth, changing legal and regulatory frameworks and climate change effects with an integrated, unified approach.

With a combination of system reoperation measures, more options can be added to the water resources management tool box to better adapt to future changes.

Figure 6-1 summarizes the relationships between system reoperation, hydrology, long-term planning and real-time operations. Box 6-1 provides information about DWR's current system reoperation study.

PLACEHOLDER Figure 6-1 Hydrology, Operations, Planning and System Reoperation Relationships

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of the chapter.]

PLACEHOLDER Box 6-1 DWR's Current System Reoperation Study

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of the chapter.]

Potential Benefits of System Reoperation

Over the last 150 years, California's water purveyors have developed their water systems in a piecemeal fashion (facilities, projects, regulations and operating rules), at different times, with various purposes, with different base data and assumptions--all of which makes it difficult to systematically consider reoperation potential for a large-scale multiple benefit system.

However, coordinated operations between the SWP, CVP, USACE and other water management agencies can add system-wide flexibility and efficiency by optimizing the existing system to meet a variety of current water management objectives. Since most of California's surface water runoff flows through the Sacramento and San Joaquin river systems and through the Sacramento-San Joaquin Delta, California's major water systems and water management agencies are intrinsically physically linked through this common point from which to examine an integrated, large-scale system reoperation approach.

At best, large-scale system reoperation can provide a way for existing water systems to collectively and efficiently adapt to uncertain future conditions with changing demands, changing legal and regulatory frameworks and changing climate.

Major Issues Facing System Reoperation Studies

Gaps in Scientific Knowledge, Data and Tools

Several significant gaps in scientific knowledge, data and tools would need to be addressed to improve the likelihood of successful large-scale system reoperation.

For example, although the field of applied environmental science has made great strides, the complex relationships between changes in key physical parameters and resultant ecosystem responses, especially over long-term periods, are still not fully understood or predictable.

The current practice of water resources engineering, planning, management and operations relies on assembling an array of computer modeling tools to depict a variety of interconnected processes. Depending on the application, these modeling tools encompass a multitude of spatial and temporal scales as graphically shown in Figure 6-2.

PLACEHOLDER Figure 6-2 Planning and Operational Tools

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of the chapter.]

The challenge in representing large-scale system reoperation scenarios lies in finding ways to integrate several modeling tools representing very complex surface water processes, climate change processes, groundwater processes, ecosystem response processes, and others given the spatial and temporal differences among them. Without an integrated water management modeling tool, it will be hard to achieve multiple-objective system reoperation meeting interconnected water supply, flood protection and eco-system restoration objectives.

As an example of the limitations of one large-scale water system operations modeling tool, one can look at CalSim. CalSim is the large-scale CVP and SWP operations planning model jointly developed and used by DWR and Reclamation for over a decade. CalSim was developed and is still used primarily to examine long-term operations from a monthly standpoint. It cannot be used for real-time flood control operations, for example, which need to assess conditions on a daily or hourly timeframe. Currently, CalSim only models surface water supplies as well as flow and salinity constraints. It cannot directly model, for example, other environmental constraints such as water temperature requirements. Thus CalSim alone is incapable of examining operations by encompassing multiple processes at once.

Competing Beneficial Uses

Prioritizing system needs will always be a great challenge in making large-scale system changes. Because many water resource systems, both on large and small scales, have been operating under the same rules for the same purposes for decades, it is important to consider the varied interests of today's beneficiaries before introducing dramatic changes. For example, many reservoirs operate for multiple purposes including water supply, flood control, hydropower generation, recreation and ecosystem benefits. Changing priorities for one use means rebalancing the others.

Climate Change

Climate change presents a huge challenge for California water management. Recent climate change studies project a broad range of potential effects such as increases in air temperature and changes in the timing, amount and form of precipitation; changes in runoff timing and volume; sea level rise; increased storm extremes; greater floods and longer droughts.

While there is much uncertainty about how climate change will impact the overall amount of precipitation in California, there is general agreement that climate change will impact both the timing and form of precipitation. Climate change studies indicate that more precipitation will fall in the form of rain instead of snow and that higher temperatures will cause earlier snowmelt. The results of these changes in precipitation form and timing will be a decrease in the overall snowpack storage as well as earlier and greater runoff from both rainfall and earlier snowmelt.

Climate Change Adaptation

Most of California's major surface water reservoirs are managed for multiple benefits but primarily water supply and flood protection. During the winter, when storms are common, flood protection takes priority and drives reservoir operation decisions. For the rest of the year, when storms are uncommon, water supply, water quality and ecosystem management drive reservoir operation decisions.

As runoff patterns shift to earlier in the year, more and more runoff will arrive during the flood operations period. Much of this water will need to pass through reservoirs (not be stored) so the reservoirs maintain adequate flood protection space. By the time the flood protection season ends, much of the runoff will have already passed through the reservoirs and won't be available in storage for use later in the year—during peak water demand periods.

In addition to changes in precipitation timing and form, climate change studies indicate sea levels may rise by as much as 55 inches at the Golden Gate Bridge by 2100. Sea level rise will increase salinity in the Sacramento-San Joaquin Delta requiring larger amounts of fresh water to control salinity for SWP, CVP and other Delta water user operations. Delta salinity requirements are one of the primary constraints guiding the operation of the SWP and CVP systems.

System reoperation measures which utilize primarily existing storage infrastructure and conveyance systems, such as conjunctive use of surface water and groundwater, could help reduce climate change impacts such as reduced snowpack, more precipitation in the form of rain and early snow melt. For example, by moving water to groundwater banking sites in the fall, reservoir levels could be lowered further so that excess water during the winter and spring can be stored in the reservoirs. This early reservoir drawdown would increase flood storage capacity and therefore improve flood protection. In turn, the water stored in groundwater banking sites would help supplement summer water supplies and decrease the reliance on reduced snowpack runoff.

Large-scale system reoperation measures, such as conjunctive use of surface water and groundwater, provide opportunities to adapt operations to climate change with an efficient and consistent approach.

Physical Constraints

The capacity of existing infrastructure, such as storage and conveyance, could limit system reoperation opportunities to make water transfers, conduct conjunctive water management, and refine flood operations. Future studies should focus on eliminating infrastructure constraints in order to add flexibility to systems.

Institutional Constraints

While there are numerous institutional arrangements that help water resource projects function together as a system, the same institutional arrangements present some very inflexible constraints that make it difficult and time consuming to consider reoperation potential of an entire system. Some of the relevant institutional constraints and the challenges they present include:

- California's priority system for surface water rights, including area of origin water rights, presents complications for large-scale changes.
- Contractual obligations for water deliveries largely constrain operations of many projects.
- Flood rule curves mandate reservation of flood control space during the flood season. Changing rule curves require Congressional approval, a difficult and time-consuming process.
- Coordinated operating agreements already govern operation of multiple projects such as the COA which governs SWP-CVP operations.
- Changes in federal project purposes require Congressional approval.

Integrating Water Resource Management

California water resources management involves many tiers and players. Facilities are operated for local, regional or nearly statewide beneficial uses. Implementing large-scale system reoperation will involve a combination of regulatory actions by local, regional, State and federal agencies.

Planning, Design and Implementation Costs

As mentioned above, significant up-front and on-going costs can be involved with system reoperation as with the planning, design, and implement of any large-scale infrastructure project.

Up-front planning and design costs might include such items as data collection, hydrologic and hydraulic model development, decision support systems development and environmental documentation necessary to just evaluate benefits and impacts of proposed reoperation strategies through the feasibility study level. Tangible implementation costs would be associated with the actual removing, modifying or constructing any new infrastructure.

Water management agencies might have difficulty raising needed funds for feasibility-level studies and implementation due to existing contracts or regulations that prohibit them from increasing water or energy rates. As with implementing any large-scale project, selling the project costs to those directly in line to receive benefits is a foregone necessity.

Recommendations to Achieve More System Reoperation

The following recommendations can help facilitate reoperation to better meet water supply reliability, flood management, hydropower, water quality, ecosystem, and other objectives:

1. State, federal, regional, and local agencies should collaborate on large-scale system reoperation studies to pool resources and share benefits.
2. The State and federal water operators should encourage and expand the use of forecast-based and forecast-coordinated reservoir operations.
3. The State should take the lead to establish a baseline hydrology applicable to large-scale system reoperations modeling.

4. The State should fund reoperation studies of smaller regional water purveyors through the IRWM grant program.
5. The State should take the lead and develop an integrated water resources analytical tool to support regional and statewide system reoperation analysis that balances water supply, flood protection, water quality and ecosystem needs. This tool would make the State a leader in large-scale integrated water management.

System Reoperation in the Water Plan

[This is a new heading for Update 2013. If necessary, this section will discuss the ways the resource management strategy is treated in this chapter, in the regional reports and in the sustainability indicators. If the three mentions are not consistent, the reason for the conflict will be discussed (i.e., the regional reports are emphasizing a different aspect of the strategy). If the three mentions are consistent with each other (or if the strategy is not discussed in the rest of Update 2013), there is no need for this section to appear.]

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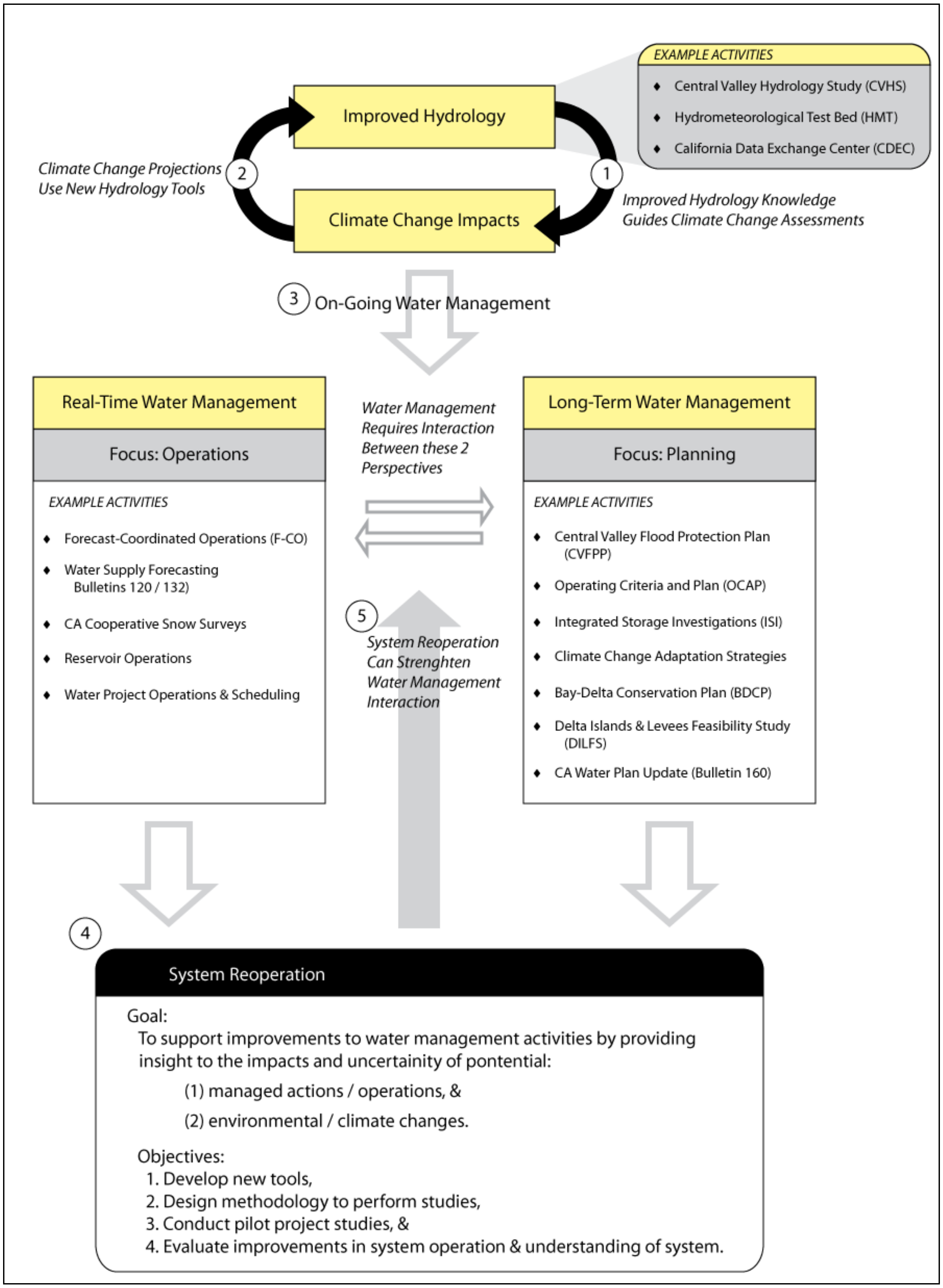
Additional References

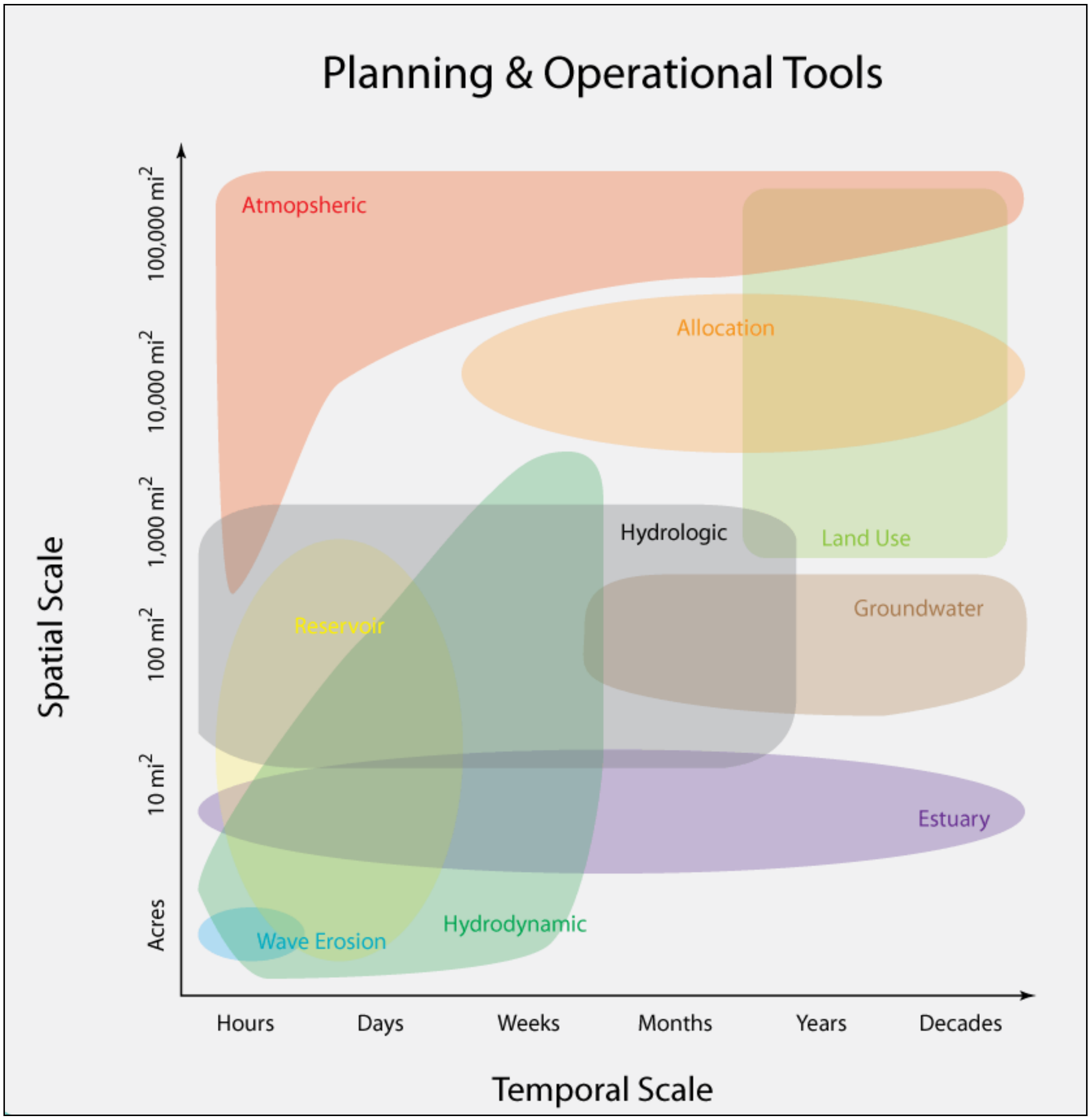
Personal Communications

Figure 6-1 Hydrology, Operations, Planning and System Reoperation Relationships



[Note: This graphic will be updated. In the box at the bottom currently labeled "System Reoperation," the "Goals" and "Objectives" bulleted lists will be replaced by "Reoperation Purposes," listing the following: (1) to address specific existing needs, (2) to improve overall operational efficiencies, (3) to adapt to anticipated future changes.]

Figure 6-2 Planning and Operational Tools



Box 6-1 DWR's Current System Reoperation Study

Senate Bill X2-1(2008) directed DWR to conduct a System Reoperation Study to identify viable reoperation strategies incorporating conjunctive surface water and groundwater use as well as considering climate change. Based upon this bill, the study was designed to meet these three primary goals:

1. Increase water supply reliability
2. Increase flood protection
3. Protect and restore ecosystems

A Plan of Study was completed in June 2011 which outlined the study goals scope and identified potential reoperation measures which could be used to form viable reoperation strategies. DWR will complete the study by Fall of 2014.

DWR's System Reoperation Study Building Blocks:

- Coordinate operations among CVP, SWP, USACE and local projects
- Reoperate reservoirs
- Integrate surface water and groundwater management
- Facilitate water transfers
- Change flow regimes (stream flow patterns)
- Expand through-valley flood conveyance and reactivate flood plains